

## DESCRIPTION

## ULTRASONIC PROBE

## TECHNICAL FIELD

5 [0001]

The present invention relates to an ultrasonic probe constituted to have an ultrasonic transducer unit suited for being inserted into a cavity of a living body for emitting ultrasonic waves into an organism of the living body and receiving echo signals therefrom.

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## BACKGROUND ART

[0002]

As far as ultrasonic probes of recent years are concerned, a variety of types have been hitherto developed. A conventional ultrasonic probe will be explained by using Figs. 7 and 8. Fig. 7 is a drawing illustrating a configuration of a conventional ultrasonic probe. Fig. 8 is a view of the ultrasonic probe shown in Fig. 7 as seen from the direction of an arrow 101. As shown in Fig. 7, the ultrasonic probe is constituted to have a grip section 1 and an insert section 2, and the insert section 2 has a configuration including a tip section 3 that in turn includes a base section 3a. A motor 5, and a drive pulley 102 which is

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swingably or rotatably driven by the motor 5 are  
incorporated inside the grip section 1. Additionally, a  
wire drive mechanism 100 which transmits power to a  
swing pulley 7 by using a wire 8 transmitting the power  
5 by the swinging or rotation of the drive pulley 102, the  
swing pulley which swings around a rotation shaft 9 by  
the power resulting from the swinging or rotation of the  
drive pulley 102 transmitted through the wire 8, and an  
ultrasonic transducer unit 4 operated by the swinging of  
10 the swing pulley 7, are incorporated in the interior of  
the insert section 2. Moreover, as shown in Fig. 8, the  
ultrasonic probe includes a position angle sensor 103,  
which detects the position angle of the ultrasonic  
transducer unit 4. Such an ultrasonic probe is  
15 disclosed in Patent document 1 indicated below.

Patent document 1: Japanese Patent Application  
Publication No. 10(1998)-179588 (Fig. 3)

[0003]

Nevertheless, in the ultrasonic probe disclosed in  
20 Patent document 1, there has been such a problem that  
the positional displacement occurs due to the slippage  
of wire 8 on the drive pulley 102 and the swing pulley 7  
while swinging. Moreover, since a mechanism had not  
been included which adjusts the origin position angle of  
25 the ultrasonic transducer unit 4 in its swing operation

when the wire 8 is attached to the drive pulley 102 and the swing pulley 7, there has been such a problem that a position angle sensor 103, which detects the position angle of the swing pulley 7 must have been incorporated.

5 Furthermore, there has been a problem such that the wire 8 used became long.

#### DISCLOSURE OF THE INVENTION

[0004]

10 The present invention was made to solve the aforementioned various problems, and it is an object to provide an ultrasonic probe, which is capable of preventing an occurrence of position displacement thereof due to the slippage of a wire on a drive pulley and a swing pulley during swinging, enabling the easy  
15 mounting of the wire thereto while adjusting the origin position angle of an ultrasonic transducer unit in swing operation without using any position angle sensor, and enabling the wire length to be shortened.

20 [0005]

According to the present invention, in order to achieve the aforementioned object, there is provided an ultrasonic probe, which comprises an ultrasonic transducer unit that emits ultrasonic waves during  
25 swinging thereof, a motor that generates a power for

swinging the aforementioned ultrasonic transducer unit,  
a first power transmission means connected to the  
rotating shaft of the aforementioned motor to transmit  
the power, a drive means connected to the aforementioned  
5 first drive transmission means to be rotated by the  
transmitted power, a second cable-like power  
transmission means transmitting the power by the  
rotation of the aforementioned drive means, a swing  
means on which the aforementioned ultrasonic transducer  
10 unit is mounted and capable of swinging the  
aforementioned ultrasonic transducer unit with the power  
from the rotation of the aforementioned drive means  
transmitted through the second drive transmission means,  
a first fixing means for fixing thereto both ends of the  
15 second power transmission means, the first fixing means  
being fixed to the swing means together with the fixed  
second power transmission means, and a second fixing  
means for fixing, to the aforementioned drive means, an  
opposite end of the second fixing means that is arranged  
20 to be opposed to a fixed end of the second power  
transmission means which is formed in a ring-shape due  
to fixing at the fixed end to the first fixing means.  
According to this configuration, it is possible to  
prevent the position of the wire which is the cable-like  
25 second power transmission means from being displaced due

to the slippage of the wire on a drive pulley which is the drive means and a swing pulley which is the swing means during swinging of the ultrasonic transducer unit, easy mounting of the wire can be achieved while  
5 adjusting the origin position angle in the swing operation of the ultrasonic transducer unit without using a position angle sensor, and shortening of the length of the wire can be realized.

[0006]

10 Moreover, in a preferred embodiment of an ultrasonic probe of the present invention, the aforementioned first fixing means is composed of a material being deformed by an external force and having a plurality of penetrating holes which are communicated  
15 with one another inside thereof, wherein pressure is applied to the aforementioned first fixing means under a condition where both ends of the aforementioned second power transmission means are drawn from one of the aforementioned plurality of penetrating holes to another  
20 hole, fixed to be one portion together with the second power transmission means, and fixed to the swing means together with the fixed second power transmission means. According to this configuration, it is possible to reduce the lift and the slippage of wire on the swing  
25 pulley.

[0007]

Moreover, in a preferred embodiment of the present invention, the second fixing means of the ultrasonic probe of the present invention is comprised of a screw that fixes the second power transmission means to the drive means. According to this configuration, it is possible to adjust and set coincidence between the origin position angle of the ultrasonic transducer unit and the origin position angle of the motor.

[0008]

Furthermore, in another preferred embodiment of the present invention, the aforementioned screw of the ultrasonic probe of the present invention is provided with a plate-like portion capable of preventing the second power transmission means from being damaged through the clamping of the aforementioned screw. According to this configuration, it is possible to prevent the wire that constitutes the second power transmission means from being damaged by threadedly clamping the screw.

[0009]

The ultrasonic probe of the present invention having the aforementioned configuration can prevent the position of the wire from being displaced due to the slippage of the wire on the drive pulley and the swing

pulley during swinging, enables easy mounting of the wire thereon while adjusting the origin position angle of an ultrasonic transducer unit in its swing operation without employing a position angle sensor, and enables  
5 shortening of the length of wire.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

[Fig. 1] A schematic view illustrating a  
10 configuration of an ultrasonic probe according to the first embodiment of the present invention.

[Fig. 2] A schematic view illustrating an internal configuration of a tip section of the ultrasonic probe according to the first embodiment of the present  
15 invention.

[Fig. 3A] A schematic view illustrating a wire, which is fixed to a fixed side wall of a connecting section in the ultrasonic probe according to the first embodiment of the present invention.

20 [Fig. 3B] A schematic view illustrating a cut section of a swing pulley in the ultrasonic probe according to the first embodiment of the present invention.

[Fig. 3C] A schematic view illustrating a  
25 connecting section where the wire is fixed to the fixed

side wall being attached to the cut section of the swing pulley in the ultrasonic probe according to the first embodiment of the present invention.

[Fig. 3D] A schematic perspective view  
5 illustrating a groove provided on the circumference of a swing pulley for permitting the wire of the ultrasonic probe according to the first embodiment of the present invention to be placed.

[Fig. 3E] A schematic perspective view  
10 illustrating a connecting section where the wire is fixed to the fixed side wall being attached to the cut section of the swing pulley having the groove where the wire is placed in an ultrasonic probe according to the first embodiment of the present invention.

15 [Fig. 4A] A schematic view illustrating a drive pulley on which the wire is placed in an ultrasonic probe according to the first embodiment of the present invention.

[Fig. 4B] A schematic view illustrating a drive  
20 pulley where a wire is fixed by clamping a screw through a plate-like portion in an ultrasonic probe according to the first embodiment of the present invention.

[Fig. 5A] A schematic view illustrating a  
connecting section having holes penetrating the center  
25 section and side wall section in an ultrasonic probe



according to the second embodiment of the present invention.

[Fig. 5B] A schematic view illustrating a connecting section where a wire is drawn from a hole of the center section and both ends of the wire are respectively drawn through the upper part and lower part of the hole in the ultrasonic probe according to the second embodiment of the present invention.

[Fig. 5C] A schematic view illustrating a connecting section where the hole is flattened by pressing to become one with the wire in the ultrasonic probe according to the second embodiment of the present invention.

[Fig. 6A] A schematic view illustrating a connecting section where the number of holes becomes three in the ultrasonic probe according to the second embodiment of the present invention.

[Fig. 6B] A schematic view illustrating a connecting section where both ends of a wire drawn through the hole are inserted into the upper part and the lower part of the hole, respectively, in the ultrasonic probe according to the second embodiment of the present invention.

[Fig. 6C] A schematic view illustrating a connecting section where a hole is flattened by pressing

to become one with a wire in the ultrasonic probe relating to the second embodiment of the present invention.

[Fig. 7] A schematic view illustrating a configuration of an ultrasonic probe according to the prior art.

[Fig. 8] A schematic view illustrating an internal configuration of the tip section of the ultrasonic probe according to the prior art.

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#### BEST MODE FOR CARRYING OUT THE INVENTION

[0011]

<First embodiment>

Hereinafter, an ultrasonic probe of the first embodiment of the present invention will be explained referring to Figs. 1 to 4B. Fig. 1 is a view illustrating a configuration of an ultrasonic probe according to the first embodiment of the present invention. Fig. 2 is a view illustrating an internal configuration of the tip section of an ultrasonic probe according to the first embodiment of the present invention. Figs. 3A through 3E are views for explanatorily illustrating the fixing of a wire to a swing pulley in an ultrasonic probe relating to the first embodiment of the present invention. Figs. 4A and

4B are views for explanatorily illustrating the fixing of a wire to a drive pulley in an ultrasonic probe relating to the first embodiment of the present invention.

5 [0012]

At first, an ultrasonic probe relating to the first embodiment of the present invention is described referring to Fig. 1. As shown in Fig. 1, the ultrasonic probe is comprised of a grip section 1 and an insert  
10 section 2 that includes a tip section 3. A motor 5 generating power for swinging an ultrasonic transducer unit 4 and an encoder 5a used for detecting the position angle of the ultrasonic transducer unit 4 are provided in the grip section 1. In the insert section 2 except  
15 for the tip section 3, a shaft 10 for transmitting the power of the motor 5 is provided. A drive pulley 6 connected to the shaft 10, a swing pulley 7 provided at the rotation shaft 9 of the ultrasonic transducer unit 4, a connecting section 11 connecting a wire 8 to the swing  
20 pulley 7, a position angle adjustment section 12 where the other end of the ring-shaped wire 8 opposed to the end connected to the swing pulley 7 is connected to the drive pulley 6, intermediate pulleys 13 and 14 transmitting the rotating operation (hereinafter, called  
25 rotation) of the drive pulley 6 to the swing pulley 7,

and a tension mechanism 15 for taking the slack away from the wire 8 are provided in the base section 3a of the tip section 3. In this example, although the wire 8 is used as a means for transmitting the power of the drive pulley 6 to the swing pulley 7, it is not intended to be limited to this example. And a structure, which has a cable shape, and similar function to the wire 8 may also be practically used.

[0013]

Next, the operation of each of the components constituting the ultrasonic probe according to the first embodiment of the present invention described in Fig. 1 will be explained using Figs 1 and 2. An operator grasps the grip section 1 and inserts the insert section 2 into a living body cavity. The drive pulley 6 connected to the shaft 10 is driven to rotate by using the motor 5 to which power is supplied, the rotating operation of the drive pulley 6 being transmitted to the swing pulley 7 by the wire 8 through the intermediate pulleys 13 and 14, and the swinging operation of the ultrasonic transducer unit 4 is performed around the rotation shaft 9. Only one each of the intermediate pulleys 13 and 14 can be seen, respectively, in Fig. 2 but the respective ones consist of pairs, respectively. The wire 8 is engageably attached to each of the

intermediate pulleys 13 and 14. The intermediate pulleys 13 and 14 are not intended to be limited to two and it may be possible a case where only one or more than three intermediate pulleys are arranged. The tension mechanism 15 in which the intermediate pulley 14 is mounted enables the removal of any slack from the wire 8 and the application of tension at the same time by pulling the intermediate pulley 14 in the direction of the arrow 16, for instance, by tightening a screw. The tension mechanism 15 may have a spring.

[0014]

When a stepping motor is used for constituting the motor 5, the position angle of the ultrasonic transducer unit 4 can be detected by using the number of pulse inputs to the stepping motor and the ratio of diameters of the drive pulley 6 and the swing pulley 7. Additionally, in the case where the encoder 5a is provided, it can be detected by using the detected angle of the encoder 5a and the ratio of diameters of the drive pulley 6 and the swing pulley 7. The ultrasonic transducer unit relating to the first embodiment of the present invention is for the case when the axis direction of the drive pulley 6 and the axis direction of the rotation shaft 9 are intersecting.

[0015]

Next, the attaching of the wire 8 and the adjustment of the origin position angle of the ultrasonic transducer unit 4 and the motor 5 will be described. First of all, the origin position angle of the swing pulley 7 on which the ultrasonic transducer unit 4 is mounted is determined as well as the origin position angle of the drive pulley 6 to which the shaft 10 connected to the motor 5 is attached. Then, the wire 8 is attached to the swing pulley 7 by the connecting section 11 and the wire 8 is stretched over the intermediate pulleys 13 and 14 and is wound around the drive pulley 6. Next, the wire 8 is fixed to the drive pulley 6 by the position angle adjustment section 12. In this manner, the respective origin position angles of the swing pulley 7 and the drive pulley 6 can be adjustably brought into coincidence with one another. Accordingly, the origin position angle of the ultrasonic transducer unit 4 and the origin position angle of the motor 5 can be adjusted to be brought into registration.

[0016]

Therefore, since the wire 8 is fixed to the drive pulley 6 and the swing pulley 7, the wire 8 does not slip on each pulley and displacement can be reduced. Moreover, since the wire 8 is made in a ring-shape, the wire 8 can be attached only by hanging on each pulley,

so that it can be easily laid down between the pulleys.  
Furthermore, the adjustment of the origin position angle  
of the ultrasonic transducer unit 4 becomes possible  
even after mounting of the ultrasonic transducer unit 4  
5 onto the rotation shaft 9 due to the position angle  
adjustment section 12 provided in the drive pulley 6.  
Herein, the aforementioned ring-shape of the wire 8 is  
not only a ring-shape in the case when both ends of the  
continuous unbroken wire 8 are attached to the  
10 connecting section 11 but also one which includes the  
case where it is essentially ring-shaped. That is, it  
includes a ring-shape made by separating one continuous  
unbroken wire 8 into two individual pieces and fixing  
each of both ends of the two individual pieces of wire 8  
15 to the drive pulley 6 and the swing pulley 7,  
respectively.

[0017]

Herein, the fixing of the wire to the swing pulley  
7 and the drive pulley 6 will be described with  
20 reference to Figs. 3A through 4B. First of all, the  
fixing of the wire 8 to the swing pulley 7 is explained.  
As shown in Fig. 3A, the fixed side wall 11a of the  
connecting section 11 on which both ends of the wire 8  
are fixed is mated with the cut section 18 of the swing  
25 pulley 7 shown in Fig. 3B and fixedly secured by using a

screw 17 and so on, as shown in Fig. 3C. Moreover, for instance, an adhesive, solder, and the like are used as a means for fixing both ends of the wire 8 to the connecting section 11. Furthermore, the number of  
5 screws 17 is not intended to be limited to two and it may be possible to have one or three or more. Therefore, since the wire 8 can be tightly fixed to the swing pulley 7 by securing the fixed side wall 11a together with the cut section 18, it is possible to reduce the  
10 lift and the slippage of wire 8 on the swing pulley 7.

[0018]

As shown in Fig. 3D, a groove 200 may be provided to extend along the circumference of the swing pulley 7 for placing the wire 8 therein, and the wire 8 can be  
15 securely fit in the groove 200 as shown in Fig. 3E, so that it is possible to reduce further the lift and the slippage of wire 8 on the swing pulley 7. Additionally, although the fixing of the wire 8 to the connecting section 11 has been explained herein, the fixing of the  
20 wire 8 may be accomplished in the same manner to the position angle adjustment section 12 instead of the connecting section 11.

[0019]

On the other hand, the fixing of the wire 8 to the  
25 drive pulley 6 will be described with reference to Figs.



4A and 4B. As shown in Fig. 4A, the wire 8 is hung on the drive pulley 6, which has been brought into registration with the origin position angle of the motor 5, and as shown in Fig. 4B, the wire 8 is fixed to the drive pulley 6 by clamping the wire 8 via the plate-like portion 19 by tightening the screw 20. Although the position angle adjustment section 12 is a screw-type in this example, it is not intended to be limited in this manner. Moreover, although the plate-like portion 19 is in the shape of a circle, it is not intended to be limited in this manner and it is possible for it to have a different shape. Furthermore, the number of screws 20 is not intended to be limited to one and it may be possible to have two or more. According to such a configuration of tightening the screw 20, it is possible for the origin position angle of the ultrasonic transducer unit 4 to be adjustably brought into registration with the origin position angle of the motor 5, and thereafter they can be securely fixed together.

[0020]

Therefore, according to the first embodiment of the present invention, displacement of the wire 8 due to slippage on the pulley can be reduced by fixing both ends of the wire 8 to the swing pulley 7 and fixing the opposite end of the ring-shaped wire 8 to the drive

pulley 6 at the position angle adjustment section 12,  
and the wire 8 can be easily mounted between the pulleys  
while carrying out adjustment of the origin position  
angle of the ultrasonic transducer unit 4 at the  
5 position angle adjustment section 12, and also  
shortening of the length of the wire 8 can be achieved.

[0021]

<Second embodiment>

Hereinafter, an ultrasonic probe according to the  
10 second embodiment of the present invention will be  
described with reference to Figs. 5A through 6C. Figs.  
5A, 5B, and 5C are drawings to explain the fixing of the  
wire to the swing pulley in an ultrasonic probe of the  
second embodiment of the present invention. Figs. 6A,  
15 6B, and 6C are drawings to explain the fixing of the  
wire to the swing pulley in an ultrasonic probe of the  
second embodiment of the present invention, similar to  
Figs. 5A, 5B, and 5C. As shown in Fig. 5A, the  
connecting section 11 is comprised of a member being  
20 deformed by an external force and has holes 21 and 22  
penetrating the center section and the side wall section.  
As shown in Fig. 5B, the wire 8 is permitted to pass  
into from the hole 21 of the center section and both  
ends of the wire 8 passed are respectively permitted to  
25 pass through the upper part and the lower part of the

hole 22. As shown in Fig. 5C, the connecting section 11 into which the wire 8 passes is compressed in the direction of arrow 23, resulting in the hole 22 being squashed and flattened to become one with the wire 8.

5 Accordingly, the wire 8 becomes ring-shaped.

[0022]

As mentioned above, a portion of the wire 8 squashed and flattened within the connecting section 11 can be made longer by passing the wire 8 not only  
10 through the hole 21 at the center section but also through the hole 22 at the side wall section, so that it is possible to reduce possibility of slipping of the wire 8 and coming out of the connecting section 11. Moreover, the wire 8 can be fixed closely to the swing  
15 pulley 7 due to the construction of the wire 8 coming out of the hole 21, so that it is possible to reduce the lift and the slippage of the wire 8 on the swing pulley 7. Although the wire 8 is fixed at the connecting section 11 in this example, the fixing of the wire 8 may  
20 be achieved in the same manner at the position angle adjustment section 12 instead of at the connecting section 11.

[0023]

Figs. 6A, 6B, and 6C are considered to be the same  
25 as Figs. 5A, 5B, and 5C. As shown in Fig. 6A, the point

where Figs. 6A, 6B, and 6C differ from Figs. 5A, 5B, and 5C is that the number of holes 22 provided at the connecting section 11 becomes two. Moreover, as shown in Fig. 6B, another differing point is in that both ends  
5 of the wire 8 drawn through the hole 21 are inserted into the upper part and the lower part of the hole 22, respectively. However, as shown in Fig. 6C, the point where a compression force is applied to the connecting section 11 in the direction of arrow 24 is the same as  
10 in Fig. 5C and the effect is also the same. Thus, according to the second embodiment of the present invention, it is possible to reduce slipping of the wire 8 and it's pulling out of the connecting section 11.

## 15 INDUSTRIAL APPLICABILITY

[0024]

An ultrasonic probe of the present invention can prevent the position thereof from being displaced due to the slippage of a wire on a drive pulley and a swing  
20 pulley while swinging, it enables the easy attaching of the wire thereto while adjusting the origin position angle of an ultrasonic transducer unit in swing operation without using a position angle sensor, and it enables the length of the wire to be shortened, so that  
25 it is useful for an ultrasonic probe for emitting

ultrasonic waves in a living organism and receiving echo signals while inserting an ultrasonic transducer unit into a living body cavity.